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(54) **Undercutter for a shaving apparatus**

Untermesser für einen Rasierapparat

Couteau intérieur pour un appareil de rasage

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## Description

### Field of the Invention

[0001] This invention relates to shaving apparatus and to methods for shaving hair from human skin.

### Background Art

[0002] Implements such as razors or electric shavers for cutting or shaving hair are well known in the prior art. Most prior art shaving implements for cutting human facial hair are designed to cut hair close to skin level, and preferably beneath that level without nicking or cutting the skin.

[0003] Conventional powered shaving devices typically cut individual hairs into a plurality of small pieces, leading to a dusty debris. Further, the resulting shaved skin may comprise stubble hairs which have not been cut in a fully satisfactory way.

[0004] Various attempts have been made to overcome this problem. For example, an electric dry shaver is disclosed in US-A-4,139,940 (Buras, Jr.) which has projections on the outer surface of the cutting foil to move and lift low lying facial hairs for cutting by underlying blades on a blade block. The blade block includes weights to cause the blade block to be unbalanced and to vibrate and move particularly in a lateral direction, which in turn causes vibration of the housing and of the foil.

[0005] Further, US-A-3,863,338 (Wellinger) describes an electric shaver comprising two cutter sections mounted in axial alignment. The two cutter sections are mounted for linear reciprocation in an aligned end-to-end relationship to avoid transmission of unpleasant vibration to the user and to avoid an unpleasant sensation due to the vibration where the shaver contacts the skin.

[0006] Furthermore, US-A-3,872,587 (Wellinger) discloses an electric shaver comprising two cutter parts which extend longitudinally and parallel to each other to avoid vibration of the shaver body in use for reasons of comfort and noise as well as for an enhanced battery life. The two cutter parts are continuously biased away from each other by two coil springs.

[0007] Also, US-A-6,151,780 (Klein) describes a dry shaving apparatus comprising two inner cutters operatively associated with a common outer cutter and arranged to be driven by a drive element, respectively, in relative opposite directions and against the force of at least one spring element to avoid vibration and running noise. The spring elements acting on both inner cutters provide a permanent compensation of vibration of the inner cutters which are arranged in parallel one after the other.

[0008] US-A-3,263,105 (Heyek) discloses dry shaving appliances wherein two independent cutters are each driven against a restoring spring, in order to keep

the apparatus as free as possible from the mechanical vibrations produced by the motor.

[0009] Further, JP 54-387 discloses two axially aligned undercutters driven in antiphase, with a portion of the respective guide blocks interfitting in each other for guidance.

[0010] Finally, US-A-2,440,061 (Page) discloses a dry shaver which comprises two end-to-end axially aligned undercutters which rotate in opposite directions due to a bevel gear arrangement.

[0011] However, conventional shaving apparatus often leaves stubble hair of a significant length in the shaved skin so that the user appears to be unshaved after a short period of time.

### Summary of the Invention

[0012] An object of the invention is to improve the cutting efficiency by increasing the number of cutting events or potential cutting events in a simple manner without the need to increase the speed of the drive motor.

[0013] According to one aspect of the invention, there is provided a shaving apparatus comprising:

- an outer cutter having a plurality of apertures;
- an undercutter assembly adjacent to said outer cutter; and
- a motor for reciprocally moving said undercutter assembly in a reciprocation direction;
- said undercutter assembly comprising a primary undercutter and a secondary undercutter which are arranged such that blade elements of the primary secondary undercutters are mutually interleaved;

wherein the primary undercutter is coupled to said motor for driving thereof in the reciprocation direction and wherein the secondary undercutter is decoupled from the motor and is mounted for movement relative to the primary undercutter in the reciprocation direction in response to the reciprocation of the primary undercutter.

[0014] It is preferred that the secondary undercutter is caused by the primary undercutter to reciprocate in lagging relationship with the primary undercutter that the primary undercutter and the secondary undercutter can cooperate for gripping hairs between the interleaved blade elements thereof and pulling the gripped hairs prior to cutting. It is preferred that the arrangement of the two undercutters is such that improved shaving closeness can be obtained. It is preferred that the secondary undercutter be nested within the primary undercutter, which can advantageously be accomplished with a biasing member such as one or more springs. In some embodiments the secondary undercutter may be mounted by springs to the primary undercutter. In other embodiments it may be mounted on the carrier block or on the shaver head frame, or to the foil frame.

[0015] According to a further aspect of the invention,

there is provided a method of shaving comprising the steps of:

reciprocally moving an undercutter assembly in contact with an outer cutter;  
trapping hairs which are to be cut between interleaved blade elements of primary and secondary undercutters of said undercutter assembly;  
pulling said trapped hairs by continued movement of the undercutter assembly in a respective reciprocation direction; and  
cutting said pulled hairs between the outer cutter and the undercutter assembly.

**[0016]** In a further aspect of the invention, there is provided an undercutter subassembly, which is useful as a replaceable part that is assembled into a dry shaver should the original undercutter assembly become dulled or damaged. The secondary undercutter is mountable within the primary undercutter such that their respective blades are interleaved and the secondary undercutter is movable relative the primary undercutter. Such an undercutter assembly could also be supplied as a retrofit to upgrade existing models of electric shavers. The secondary undercutter can be biased either directly to the primary undercutter or independent of the primary undercutter by being biased to a carrier which supports the undercutter assembly. A method is described whereby the reciprocating primary undercutter causes the secondary undercutter to be moved, and preferably lag in relation to the primary undercutter.

**[0017]** When the primary undercutter is driven in a reciprocation direction, the blade elements of the undriven secondary undercutter initially lag behind the blade elements of the primary undercutter. Then, the blade elements of the primary undercutter can contact the blade elements of the secondary undercutter as a result of continued movement of the primary undercutter in the reciprocation direction and hairs are gripped between the interleaved blade elements of the primary and secondary undercutters, which form gripping elements. Thereafter, the primary undercutter moves further so that the secondary undercutter is pushed in the reciprocation direction and gripped hairs are pulled somewhat out of their follicles. The primary undercutter pushes the secondary undercutter together with the gripped hair until the adjacent surfaces of the primary and secondary undercutter have passed underneath a cutting edge of the outer cutter, so that the gripped hairs are cut by being sheared between the outer cutter and the adjacent blade elements of the undercutter assembly.

**[0018]** Thereafter, the primary undercutter reverses its direction, so that the above sequence of events is repeated.

**[0019]** By gripping and pulling the hairs between the blade element of the primary and secondary undercutter prior to cutting, debris can be cut off with a greater length as compared to conventional dry shaving. Additionally,

the stubble hairs which remain in the skin are shorter, since the gripped hairs are pulled prior to cutting and the remaining stubble hairs retreat after cutting (the so-called hysteresis effect). As a result, improved closeness is achieved so that a smooth shaved skin is obtained.

#### Brief Description of the Drawings

**[0020]** Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a shaver having a shaver head having two cutter units with the outer cutters removed and one undercutter assembly shown only in part;

Figure 1A is a perspective view of an undercutter unit for use in the shaver head of Figure 1;

Figure 2 is a perspective view partly broken away of an undercutter assembly in a rest position in shaving apparatus according to an embodiment of the invention;

Figure 3 is a perspective view partly broken away of the undercutter assembly of Figure 2 with a primary undercutter moving in a first direction;

Figure 4 is a perspective view partly broken away of the undercutter assembly of Figure 2 and 3 with the primary undercutter driven in a second direction;

Figure 5 is a perspective view of the undercutter assembly of Figures 2 to 4;

Figure 6 is a schematic view of a shaver head according to a first embodiment of the invention;

Figure 7 is a schematic view of a shaver head according to a second embodiment of the invention;

Figures 8a to 8i show schematic views of blade elements of an undercutter assembly and a cutting foil sequentially illustrating the operation of a shaving apparatus according to an embodiment of the invention;

Figure 9 shows a perspective view of a shaver having a shaver head having two cutter assemblies of the type shown in Figure 7, with the outer cutter removed, and one undercutter assembly shown only in part to expose the bias springs; and

Figure 10 shows a modification of the embodiment of Figure 7.

#### Description of Preferred Embodiments and Best Mode of Practicing the Invention

**[0021]** Figure 1 shows a shaver having a shaver head of the type having two cutter units, each having a respective undercutter assembly and an outer cutter or foil. For clarity, Figure 1 shows only a scrap view of the outer cutters 60,61 (which are conventional) mounted in a foil frame 19. A first undercutter assembly 10 is

shown complete in its assembled condition. Only part of the second undercutter assembly is shown.

[0022] Each undercutter assembly such as 10 comprises a primary cutter, a secondary cutter, a support block 23, and a sub-mounting 80 which carries a spring 50, preferably at least two springs 50, as illustrated in Figure 1. For the second undercutter assembly, only the sub-mounting 80 and two springs 50 are shown. It is understood that presence of spring or springs 50 is not essential to practicing the present invention, but is preferred for better shaving efficiency. It is understood that the sub-mounting 80 is part of the drive block, which is known in the art and is conventionally driven by a motor in the handle unit housing 98, via a drive shaft 99. As is known in the art, sub-mounting 80 is removably attached to the shaver by a drive member, e.g. a pin 90, which connects it to the drive pin of the shaver, and is shown in Figure 1A.

[0023] Figure 1A shows an undercutter unit comprising the first and second undercutter assemblies of Figure 1. Each undercutter assembly, such as assembly 10 as shown, is mounted on the common sub-mounting 80, which also provides a downwardly depending drive member 90, which is commonly formed as a pin member, which engages with a complementary recess on the drive housing to receive motive power from the shaver motor 100.

[0024] Figure 2 shows a perspective view of the first undercutter assembly 10 comprising a primary undercutter 20 and a secondary undercutter 30, with the support block removed. The primary undercutter 20 and the secondary undercutter 30 are partly shown in cross section along a vertical plane which divides both elements substantially into two halves.

[0025] The primary undercutter 20 comprises a plurality of blade elements 21 which are uniformly spaced apart and have an annular form, so that the outer and inner surfaces of the blade elements 21 each substantially form a semi-cylindrical shape. Similar to the primary undercutter 20, the secondary undercutter 30 comprises a plurality of blade elements 31 which are uniformly spaced apart and have a substantially annular form, so that the outer and inner surfaces of the blade elements of the secondary undercutter each also substantially form a semi-cylindrical shape. The blade elements 31 are interleaved with the blade elements 21 of the primary undercutter.

[0026] Figure 2 shows a static or neutral position of the undercutter assembly 10, where the blade elements 21 of the primary undercutter and the blade elements 31 of the secondary undercutter 30 are equidistant from one another. It will be understood that the secondary undercutter 30 of semi-cylindrical shape is adapted to be nested within the semi-cylindrical shape of the primary undercutter 20, to achieve the interleaving of the blade elements.

[0027] For positioning of the secondary undercutter 30 relative to the primary undercutter 20, a secondary

spring element 40 is provided which is coupled to the primary undercutter 20, on the one hand, and the secondary undercutter 30, on the other hand. The secondary spring element 40 is preferably a coil spring. While in some arrangements one spring element 40 could be used, it is preferred to have two spring elements 40, one at each end. In particular, the coil spring 40 is connected at one end to the primary undercutter 20 by means of a boss or protrusion 22, which extends from support block 23 of the primary undercutter 20 that is substantially opposite to the blade elements 21 of the primary undercutter 20. The other end of the spiral spring 40 is connected to a lug 32 arranged within the semi-cylindrical shape of the secondary undercutter 30. A base plate 33 of the secondary undercutter 30 has a recess 34 through which the coil spring 40 passes from the boss 22 of the primary undercutter 20 to the lug 32 of the secondary undercutter 30. In the static position shown in Figure 2, the coil spring 40 may optionally be preloaded to bias the secondary undercutter 30 into engagement with the outer shaving foil 60 (see Fig. 8a ).

[0028] Figure 3 shows the cutter assembly 10 of Figure 2 when the primary undercutter 20 is moving to the left (as indicated by the larger arrow) in one direction of the reciprocating movement caused by the motor (Fig. 1), whilst the secondary undercutter 30 is still moving to the right (as indicated by the smaller arrow) in the other direction of the reciprocating movement, due to its inertia. The coil spring 40 serves as a resilient connection between the primary undercutter 20 and the secondary undercutter 30, so that the blade elements 31 of the secondary undercutter 30, which is decoupled from the motor, lag behind the blade elements 21 of the driven primary undercutter 20. This action of using the moving primary undercutter to actuate the mass of the secondary undercutter is a reason that the secondary undercutter may be termed, as a matter of convenience, an "inertial undercutter".

[0029] In Figure 3, the blade elements 21, 31 of the primary and secondary undercutters 20, 30 are shown contacting each other at adjacent surfaces, and thus hairs can be trapped in between these adjacent surfaces of the blade elements 21, 31 to produce a "tweezer effect". By virtue of the movement of the primary undercutter 20, and the lagging of the secondary undercutter 30, the spiral spring 40 is extended with one end of the spiral spring 40 displaced further in the reciprocation direction than the other end, so that the spring is inclined to the right as shown in Figure 3. This is achieved without changing the position of the primary undercutter 20 relative to the secondary undercutter 30 in a direction normal to the reciprocation direction.

[0030] As can be seen in Figure 4, when the primary undercutter 20 is driven to the right as indicated by the larger arrow, and the secondary undercutter 30 is still moving to the left due to its inertia, as indicated by the smaller arrow, the same hair trapping or tweezer effect occurs as discussed with respect to Figure 3. The coil

spring 40 is now inclined and extended to the left.

[0031] As a result of the lateral movement of the primary undercutter 20 as described above, adjacent blade elements of the primary and secondary undercutters come into contact with one another as the blade elements 31 of the secondary undercutter lag behind the blade elements 21 of the primary undercutter 31, due to the inertia of the secondary undercutter, friction forces from contact with the foil, and the spring connection between the primary and secondary undercutters 20, 30. By virtue of the reciprocating movement of the primary undercutter 20, each blade element 21 of the primary undercutter 20 comes into contact alternately with the adjacent right and left blade elements 31 of the secondary undercutter 30 corresponding to the reciprocation direction of the primary undercutter 20, as can be understood from Figure 3 and 4.

[0032] As a result of the resilient support of the secondary undercutter 30 by the coil spring 40 and as a result of the contact of the blade elements 21, 31 of the primary and secondary undercutter 20, 30, the secondary undercutter 30 can bounce back and forth, due to its inertia, between the driven blade elements 21 of the primary undercutter 20, so that the primary undercutter 20 and the secondary undercutter 30 cooperate to trap and pull hairs between their interleaved blade elements 21, 31 prior to cutting, as will be described hereinafter in more detail.

[0033] Some factors that are likely to influence the motion of the secondary undercutter include: foil loading, secondary spring pressure, speed of oscillation, deformation of individual blades, asymmetries in either the undercutter construction or the drive motion, and the mass of the secondary undercutter. The secondary undercutter itself typically weighs 0.39 grams. Optionally, it can be fitted with a steel "bob-weight" attached inside at each end of the undercutter; for example weights up to 0.17 gram each could be accommodated without interfering with the spring mountings, thus the additional mass of the two bobweights representing an 87% increase in the mass.

[0034] Figure 5 shows a perspective view of the cutters of undercutter assembly 10. The secondary undercutter 30 is nested inside the primary undercutter 20, with the blade elements 21, 31, respectively, of the primary and secondary undercutters 20, 30 mutually interleaved as described above. The blade elements 21, 31 of the primary and secondary undercutters 20, 30 are both arcuate, and the outer diameter of the blade elements 31 of the secondary undercutter 30 are ground to match the outer diameter of the blade elements 21 of the primary undercutter 20.

[0035] In practical tests comparing a production-type Braun electric shaver Model 6017, (widely sold in the United States and Europe under the trade designation "Syncro"), with the same model modified according to the embodiment of the type shown in Figures 1 to 5, it was observed from a histogram analysis of shaving de-

bris that the modified Model 6017 having the undercutter assembly of the present invention cut more hairs of a longer length than the standard Model 6017 shaver, with a corresponding reduction in the number of shorter (less than 50 micron length) hair. Thus, there was advantageously less short "dust"-type debris (about half as much) which might tend to foul the parts and be more difficult to clean from the shaver elements.

[0036] The support block 23 of the undercutter assembly has an engagement region 24 for receiving elements that transfer the reciprocating movement of the motor to the primary undercutter 20. As seen in Figure 1A, engagement region 24 is pinned at the circular region to a separate cover piece which covers springs 50 and resiliently rides on springs 50; the attachment of engagement region 24 is preferably pivotally pinned to this cover piece. Furthermore, the support block 23 can have receiving sections which are accessible from below for receiving the pair of primary biasing elements 50 as shown in Figure 1, 6 and 7. The support block 23 and sub-mounting 80 or 80b can be removable as a unit for convenient replacement, since the sub-mounting 80 or 80b can have on its underside attachment structure such as the pin or lug 90 shown in Figure 1A, which is known in the art as shown in U.S. Pat. 6,098,289 (Wetzel) (see for example therein drive pin 44 in Figures 2 and 11), to removably connect the assembly to the main drive member 99 (driven by the motor 100) that is retained in the shaver body housing 98. Alternatively, support block 23 can have attachment structure so that it is possible to exchange just the primary and secondary undercutters while leaving sub-mounting 80 or 80b in place, such as by having on the underside of the primary undercutter a rib defining detent structure or an opening into which an arm or protrusion formed on an upper surface of sub-mounting 80 or 80b can be snapped or retained, as shown in either of U.S. Pat. 5,159,755 (Jestädt et al.) or U.S. Pat. 4,797,997 (Packham et al.).

[0037] Figures 6 and 7 illustrate, schematically, embodiments of shaver heads which comprise an outer cutter, that is a cutting foil 60, adjacent to the undercutter assembly 10, consisting of the primary and secondary undercutters 20, 30 whose blades are interleaved. As described with reference to Figures 1 to 4, the arrangement of Figure 6 has a pair of secondary spring elements 40 arranged between the primary undercutter 20 and the secondary undercutter 30. In this arrangement, with the primary and secondary spring elements in series, the secondary undercutter is referred to as being "internally sprung". In such an arrangement, the preload of the primary biasing elements 50 influences the preload of the secondary biasing elements 40, and vice versa, since they are coupled. Therefore, the preload of the secondary biasing elements 40 causes the primary undercutter 20 to be pushed away from the cutting foil 60 by the preload of the secondary biasing elements 40, which may possibly decrease the cutting efficiency. For example, primary springs were selected that apply a

nominal loading force of 200 gram against the shaving foil, which is in the loading range of conventional undercutters such as in commercially available shavers from Braun sold under the designation Model 6016. However, the resultant primary undercutter loading against the shaving foil was then 200 gm minus the secondary spring loading. The nominal loading of the primary undercutter can alternatively be 180 grams, which is known in commercial shavers from Braun sold under the designation Model 6017; thus a primary nominal loading in the range of 150-200 grams is common.

[0038] In an alternative arrangement which tends to optimise the cutting efficiency, biasing elements as illustrated in Figure 7 can be employed. A pair of secondary biasing elements 41 extend from the secondary undercutter 30 through the primary undercutter 20 to mounting points which are not arranged at the primary undercutter 20. In this arrangement with the primary and secondary springs in parallel the secondary undercutter is referred to as being "independently sprung". Thus, the primary biasing element 50 and the secondary biasing element 41 are arranged in a similar manner, and preferably carried on a fixed spring carrier 80b (shown schematically in Fig 7) to avoid interference between the preloads of the primary undercutter 20 and the secondary undercutter 30. This arrangement maintains the primary undercutter spring loading of nominally 200 grams, unaffected by the secondary loading. A more detailed view of the arrangement of Figure 7 is shown in Figure 9. As with Figure 1, the outer cutters are omitted and one undercutter assembly is shown only in part to expose the springs. It has been observed that the secondary undercutter, when using the "independently sprung" arrangement, moves in a more controlled and regular manner than with the "internally sprung" arrangement, with a more distinct flip-flop action (that is, where the secondary blade elements meet the primary blade elements at each end of the stroke) and less bouncing when its blade elements make contact with the blade elements of the primary undercutter.

[0039] The spring carrier 80b is similar to the sub-mounting 80 but is extended to include additional ears or wings to position secondary springs 41. It is not necessary that the biasing elements 41 be mounted to the same structure as biasing elements 50. Since the primary undercutter preferably has a tubular shape open at both ends, it will be understood that, in an alternative embodiment, biasing elements 41 could extend out the ends of primary undercutter 20 and be mounted to support pins formed on the foil supporting frame 19 which is attached to head frame 18, or alternatively to the head frame 18 directly, each of which is static relative to primary undercutter 20, although such a construction is less preferred from the standpoint of easy interchangeability of the shaving foil or undercutter assembly.

[0040] The arrangement of Figure 7 also offers easier access to the springs, avoids production variation problems associated with "short springs", and also offers a

possibility for convenient adjustability by the user of the spring force of the secondary springs, for example by having the spring connected to a set screw that is accessible through the shaver housing by a user's finger to adjust the preload. The spring bias has been varied stepwise to supply a nominal loading of the secondary undercutter against the shaving foil of 50-60 grams to 300 grams and slightly above. A nominal loading of 60 gram is understood to be satisfactory for the secondary undercutter. It is also understood that a nominal loading of 160 grams is also acceptable, and it may be preferable to have this nominal loading in the range of 50 to 200 grams. Thus, in some embodiments the nominal loading of the secondary undercutter is lower than or up to about the same as the nominal loading of the primary undercutter.

[0041] In shave tests, the internally sprung arrangement initially had a preload of 120 gram, but this was reduced to 50 gram to minimize the effect on the primary undercutter loading. In further tests using the independently sprung arrangement, the secondary preload could then be varied without affecting the primary loading. A comparison of 160 gram preload with 60 gram preload indicated that 60 gram was preferred by the test subjects, so this preload was selected for subsequent testing.

[0042] In tests on a rig, it has been shown that with an increasing secondary bias, friction between the undercutter and shaving foil may reach a point where the inertial action of the secondary undercutter tends to be lost. If the secondary cutter bias is increased too much, which in tests occurs in the region of about 230 grams nominal loading, the springs, if not stiff enough, buckle slightly causing the secondary undercutter to rotate within the primary undercutter with the consequence that the curved lower profiles of the gap between the two sets of undercutter blades prevent their mutual contact and the "gripping" action may decrease. Under a nominal loading of 320 grams it was observed that the secondary undercutter still performed as expected, though effects of increasing friction became evident as the cutter slowed down. However, under some circumstances, even a nominal loading of 260 grams could be too high and possibly cause the shaving foil to become dislodged. With light external loading applied to the foil, the secondary undercutter was observed to drag at 200g and to stop at 280g.

[0043] Referring now to Figures 8a to 8i, the operation of the shaving apparatus as presently understood will now be described in more detail. When the skin to be shaved (not shown) is in contact with the cutting foil 60, hairs 70 extend through apertures 61 of the cutting foil 60 for engagement with the undercutter assembly including blade elements 21 and 31. The positions of the primary undercutter blades 21 and the secondary undercutter blades 31 in Figure 8a correspond to their positions in Figure 1, with the primary blade elements 21 spaced equidistantly from the secondary blade ele-

ments 31. As indicated by the two arrows, the primary blade elements 21 are initially to be moved in a first lateral direction (to the left) by a motor (not shown). Since the secondary blade elements 31 are not driven by the motor, or at least not directly, their position relative to the cutting foil is considered to remain as substantially unchanged during the first lateral movement of the primary elements 21, due to the inertia of the secondary blade elements 31. However, dynamic effects may cause a variety of relative movements of the secondary blade elements 31 which are not considered in the following.

[0044] As shown in Figure 8b, the primary blade elements 21 catch the hairs 70 and push them against the secondary blade elements 31 so that the hairs 70 are pinched between adjacent blade elements 21, 31 of the primary and secondary undercutter 20, 30.

[0045] As the primary blade elements 21 then move further in the first lateral direction (to the left), the secondary blade elements 31 are pushed by the primary blade elements 21, also to the left, with the hairs 70 trapped between the adjacent blade surfaces, so that the hairs are pulled. As a result, the root 71 of the hair 70 is pulled somewhat out of its follicle and towards the edge of an aperture in the cutting foil 60, as indicated in Figure 8c and 8d where the original position of the root 71' is shown in ghost lines.

[0046] Figure 8d shows that the hair 70 is cut while being trapped between adjacent surfaces of primary and secondary blade elements 21, 31. The hair 70 is sheared as a result of co-operation between the blade elements and the cutting foil. However, the hairs 70 can also be sheared when not trapped between adjacent surfaces of primary and secondary blade elements, but simply while they are pushed only by a single blade element of the primary or secondary undercutter 20, 30.

[0047] Figure 8e shows the primary blade elements 21 being driven in a second lateral direction (to the right) opposite to the first lateral direction, due to the reciprocating movement of the primary undercutter 20, as indicated by the two arrows. Thereby, the secondary blade elements 31 lose contact with the primary blade elements 21, and become spaced apart from each other due to inertial effect of the secondary undercutter 30. Since the hairs 70 have just been cut as shown in Figure 8d, the root 71 of the hair 70 then retreats into the follicle back to its original position, so that the remaining stubble hair moves beneath the skin surface, resulting in improved closeness.

[0048] Regarding Figures 8f to 8i the same sequence of operational steps takes place but in mirror image to the corresponding Figures 8a to 8e. In particular, Figure 8f shows primary blade elements 21 moving further in the second direction and coming into contact with new hairs 70 which pass through the apertures 61 of the cutting foil 60. In Figure 8g the hair is then trapped between adjacent primary and secondary blade elements 21, 31 and pulled prior to being cut. Thereafter, the hairs are

cut, while being pulled, as described above. As indicated by Figure 8i, the primary blade elements 21 then move back in the first direction due to the reciprocating movement of the primary undercutter 20 and the roots 71 of the hairs 70 move back again into their follicles to adopt the original positions.

[0049] The above-described sequence is then repeated, starting from Fig. 8a again. However, it should be mentioned that the above schematic illustration is only one possibility as to how hairs can be trapped between adjacent blade elements and pulled out of their follicles, prior to being cut while they are still trapped. Also, hairs can be cut after they have been trapped and pulled away from their follicles by adjacent primary and secondary blade elements, or in the normal way without being pulled. The reason for this is that the secondary blade elements will bounce back and forth between the driven primary blade elements. Alternatively, the secondary undercutter can be mounted for movement relative to the primary undercutter in the reciprocation direction by a resilient or movable support of the secondary undercutter, e.g. ball bearings in the housing. Furthermore, the secondary undercutter can also be freely movable between the interleaving blade elements of the primary undercutter, that is, guided within the primary undercutter but not biased by a spring relative to the primary undercutter.

[0050] Whereas the embodiments described above envisage that both the primary and secondary undercutters are manufactured from metal, the secondary undercutter may alternatively be manufactured from a plastics material. In particular, it may be manufactured by machining from a solid rod with the blades formed by circumferential grooves cut into its surface. A plastics material secondary undercutter may be quieter in operation than a metal one as well as providing the option of including filler particles, for example, carbide, for improved gripping action and wear resistance. The blade elements of the secondary undercutter do not have to be sharpened, even if they are made of metal; they could for example be relatively blunt, they could have a high friction coating, or they may be ground to only cut hairs in one direction of travel. They could, for example, be made of plastic and textured and/or include an elastomer to provide a good frictional surface.

[0051] Another possible embodiment, shown schematically in Fig. 10 involves the use of magnets 101, 102 in order to increase the gripping effect over that provided by the inertial effect alone. For such an embodiment magnets 101, 102 would be disposed at the ends of the undercutters, the secondary undercutter for example providing poles of one polarity at the ends of a plastics undercutter, and the primary undercutter providing poles of the opposite polarity at its ends, thereby achieving a flip-flop action and biasing the blades to either be in the gripping position at the right or the left. It will be understood that the magnets can be used with a spring arrangement of the type shown in either Figure

6 or Figure 7.

[0052] As will be appreciated, if the primary undercutter is a standard undercutter, adding the secondary undercutter will effectively double the number of blades, and possibly result in reduced shaving efficiently due to there being too many blades oscillating beneath the foil. The primary undercutter may therefore desirably have less blades than a standard undercutter, so that when a secondary undercutter with a similar number of blades to the primary undercutter is employed, an undercutter with the same number of blades overall as a standard undercutter results.

[0053] Because the secondary undercutter is nested within the primary undercutter it is less wide, so the secondary undercutter is tangential with the shaving foil in an effective cutting range, in the width direction, of somewhat less than 4 mm. However, in arrangements where the secondary undercutter had a similar distribution of blade elements as a conventional primary undercutter (e.g., 27 blade elements each of 0.12 mm thickness evenly spaced over a length of 31 mm as in commercial Braun shavers sold under the "Syncro" designation Model 6016 or 6017), each blade element of the secondary undercutter was observed, during linear reciprocation, to move across five (5) of the honeycomb-like-distributed apertures in the shaving foil (each of which has a typical size of 0.6mm in width), in comparison to the blade elements of the primary undercutter which moved across only three (3) apertures, thus the secondary undercutter moved 66% more than the primary undercutter, generating more possible blade element-to-aperture interactions, and increasing the likelihood of generating a hair cutting event especially whenever the blade elements of the two undercutters remain in hair-trapping or clamping relation for a distance of travel exceeding 0.6mm.

[0054] It has been observed that since the secondary undercutter adds extra mass to the dynamic system, it may result in an increase in shaver head and body vibration, and that it may be beneficial to add a counterbalance weight attached to the motor to counteract that.

[0055] Further modifications will occur to those skilled in the art.

## Claims

### 1. A shaving apparatus, comprising:

an outer cutter having a plurality of apertures;  
an undercutter assembly adjacent to said outer cutter; and  
a motor for reciprocally moving said undercutter assembly in a reciprocation direction;  
said undercutter assembly comprising a primary undercutter and a secondary undercutter which are arranged such that blade elements of the primary and secondary undercutters are

mutually interleaved;

characterised in that the primary undercutter is coupled to said motor for driving thereof in the reciprocation direction and wherein the secondary undercutter is mounted for movement relative to the primary undercutter in the reciprocation direction such that, in response to the reciprocation of the primary undercutter, the secondary undercutter reciprocates relative to the primary undercutter.

2. A shaving apparatus according to Claim 1, wherein said secondary undercutter is mounted to the primary undercutter.

3. A shaving apparatus according to Claim 1, wherein said secondary undercutter is mounted independent of the primary undercutter.

4. A shaving apparatus according to any of Claims 1 to 3, wherein the primary and secondary undercutters are carried on a support block which is moveable in the reciprocation direction.

5. A shaving apparatus according to any of Claims 1 to 4, wherein the primary undercutter is biased towards the outer cutter by a primary biasing element and wherein the secondary undercutter is biased to the outer cutter by a secondary biasing element.

6. A shaving apparatus according to Claim 5, wherein a first end of the secondary biasing element is connected to the primary undercutter and a second end of secondary biasing element is connected to the secondary undercutter.

7. A shaving apparatus according to Claim 6, wherein the secondary biasing element comprises a pair of coil springs.

8. A shaving apparatus according to Claim 6, wherein the primary and secondary biasing elements are arranged on at least one carrier.

9. A shaving apparatus according to Claim 5, wherein respective first ends of the primary and secondary biasing elements are connected to a carrier and respective second ends of the primary and secondary biasing elements are connected to respective primary and secondary undercutters.

10. A shaving apparatus according to Claim 8 or 9, wherein at least one of the primary biasing element and the secondary biasing element is pre-biased by spacers which are disposed between the respective biasing element and the carrier.

11. A shaving apparatus according to any one of Claims



- 1 to 10, wherein said secondary undercutter is nested within said primary undercutter and an outer circumference of the cutter assembly is formed by peripheral edges of the interleaved primary and secondary blade elements.
12. A shaving apparatus according to any one of Claims 1 to 11, wherein the secondary undercutter comprises a plastics material.
13. A shaving apparatus according to any one of Claims 1 to 12, further comprising a magnet for biasing the blade elements of the secondary undercutter into contact with the blade elements of the primary undercutter in at least one reciprocation direction.
14. A shaving apparatus according to Claim 13, wherein the secondary undercutter carries at least one pole of a first polarity and the primary undercutter has, adjacent the at least one pole of the secondary undercutter, at least one pole of a second polarity opposed to said first polarity.
15. A shaving apparatus according to any one of Claims 1 to 14, wherein the secondary undercutter reciprocates in lagging relationship to the primary undercutter.
16. A shaving apparatus according to any one of Claims 1 to 15, wherein the secondary undercutter and the primary undercutter cooperate such that the interleaved blade elements move towards one another.
17. A shaving apparatus according to Claim 16, wherein the interleaved blades move towards one another in clamping relationship to hairs trapped therebetween.
18. A shaving apparatus according to Claim 17, wherein the cooperating secondary undercutter and primary undercutter pull said trapped hair prior to cutting of said hair.
19. An undercutter assembly for a shaver of the dry-type having an outer cutter and a motor drive mechanism, said undercutter assembly comprising:
- a primary undercutter adapted to be reciprocated by the drive mechanism and having primary blade elements;
- characterised in** a secondary undercutter disposed within said primary undercutter for displacement relative said primary undercutter and having secondary blade elements interleaved with said primary blade elements.
20. An undercutter assembly according to Claim 19,
- wherein said secondary undercutter is mounted to the primary undercutter.
21. An undercutter assembly according to Claim 19, wherein said secondary undercutter is mounted independent of the primary undercutter.
22. An undercutter assembly according to any one of Claims 19 to 21, wherein
- the primary biasing element is adapted to bias the primary undercutter to the outer cutter and
- the secondary biasing element is adapted to bias the secondary undercutter to the outer cutter.
23. An undercutter assembly according to Claim 22, wherein the secondary biasing element comprises a pair of coil springs.
24. An undercutter assembly according to Claim 22 or 23, wherein a first end of the secondary biasing element is connected to the primary undercutter and a second end of secondary biasing element is connected to the secondary undercutter.
25. An undercutter assembly according to Claim 22 or 23, further including a carrier and wherein respective first ends of the primary and secondary biasing elements are connected to the carrier and respective second ends of the primary and secondary biasing elements are connected to respective primary and secondary undercutters.
26. An undercutter assembly according to any one of Claims 19 to 25, wherein said secondary undercutter is nested within said primary undercutter and an outer circumference of the undercutter assembly is formed by peripheral edges of the interleaved primary and secondary blade elements.
27. An undercutter assembly according to any one of Claims 19 to 26, wherein the secondary undercutter comprises a plastics material.
28. An undercutter assembly according to Claim 27, wherein the blade elements of the secondary undercutter comprise a plastics material having enhanced frictional characteristics.
29. A method of shaving for use with shaving apparatus having an undercutter assembly having a primary undercutter and a secondary undercutter, said primary and secondary undercutters having interleaved blade elements; the method comprising the steps of:
- reciprocally moving the undercutter assembly in hair shearing relation with an outer cutter; moving the primary undercutter relative to the

secondary undercutter;  
trapping hairs which are to be cut between interleaved blade elements of the primary and secondary undercutters ;  
pulling said trapped hairs by continued movement of the undercutter assembly in a respective reciprocation direction; and  
cutting said hairs between the outer cutter and the undercutter assembly.

30. A method of shaving for use with shaving apparatus having an undercutter assembly having a primary undercutter and a secondary undercutter, said primary and secondary undercutters having interleaved blade elements; the method comprising the steps of:

reciprocally moving the undercutter assembly in hair shearing relation with an outer cutter;  
moving the primary undercutter relative to the secondary undercutter in a first reciprocation direction;  
whereby said moving primary undercutter entrains the secondary undercutter and continued movement of the primary undercutter constrains the secondary undercutter to move with the primary undercutter in the first reciprocation direction,  
reversing direction of moving the primary undercutter,  
whereby continued motion of the primary undercutter causes the secondary undercutter to reverse direction, and  
cutting hairs between the outer cutter and the undercutter assembly.

31. A method according to Claim 29 or 30, including the step of causing the secondary blade elements to move relative to the primary blade elements in the reciprocation direction in a lagging relation with respect thereto, whereby to provide contact between adjacent blade elements for trapping said hairs.

32. A method as claimed in Claim 31, wherein the secondary undercutter blades lag relative to the primary undercutter blades in response to the inertia of the secondary undercutter.

33. A method according to any one of Claims 29 to 32, further comprising the steps of:

biasing the primary blade elements towards the outer cutter by a primary biasing element; and

biasing the secondary blade elements towards the outer cutter by a secondary biasing element.

34. A method according to Claim 33, further comprising

the step of positioning the secondary biasing element between the secondary undercutter and the primary undercutter.

35. A method according to Claim 33, for use with shaving apparatus further having a carrier external of the primary undercutter, and the method further comprising the steps of:
- biasing the primary undercutter to the carrier through the primary biasing element; and  
biasing the secondary undercutter to the carrier through the secondary biasing element.

#### Patentansprüche

1. Rasierapparat, der umfasst:

ein mit einer Vielzahl von Öffnungen versehenes Obermesser;  
eine dem Obermesser benachbarte Untermesser-Baugruppe; und  
einen Motor, der die Untermesser-Baugruppe in eine Hin- und Herbewegung versetzt;

wobei die Untermesser-Baugruppe ein erstes Untermesser und ein zweites Untermesser aufweist, die so angeordnet sind, dass Messerblätter des ersten und zweiten Untermessers wechselseitig ineinander eingreifen;  
**dadurch gekennzeichnet, dass** das erste Untermesser mit dem Motor gekoppelt ist, um in Richtung der Hin- und Herbewegung angetrieben zu werden, und das zweite Untermesser gegenüber dem ersten Untermesser hin und her bewegbar so gelagert ist, dass das zweite Untermesser in Abhängigkeit von der Hin- und Herbewegung des ersten Untermessers gegenüber dem ersten Untermesser eine Hin- und Herbewegung ausführt.

2. Rasierapparat nach Anspruch 1, wobei das zweite Untermesser an dem ersten Untermesser gelagert ist.

3. Rasierapparat nach Anspruch 1, wobei das zweite Untermesser unabhängig von dem ersten Untermesser gelagert ist.

4. Rasierapparat nach einem der Ansprüche 1 bis 3, wobei das erste und das zweite Untermesser auf einem Trägerblock gelagert sind, der in Richtung der Hin- und Herbewegung bewegbar ist.

5. Rasierapparat nach einem der Ansprüche 1 bis 4, wobei das erste Untermesser von einem ersten Vorspannelement in Richtung auf das Obermesser vorgespannt ist und das zweite Untermesser von ei-

- nem zweiten Vorspannelement gegen das Obermesser vorgespannt ist.
6. Rasierapparat nach Anspruch 5, wobei ein erstes Ende des zweiten Vorspannelements mit dem ersten Untermesser verbunden ist und ein zweites Ende des zweiten Vorspannelements mit dem zweiten Untermesser verbunden ist.
7. Rasierapparat nach Anspruch 6, wobei das zweite Vorspannelement aus zwei Schraubenfedern besteht.
8. Rasierapparat nach Anspruch 6, wobei die ersten und zweiten Vorspannelemente auf wenigstens einem Träger angeordnet sind.
9. Rasierapparat nach Anspruch 5, wobei die jeweiligen ersten Enden der ersten und zweiten Vorspannelemente mit einem Träger verbunden sind und die jeweiligen zweiten Enden der ersten und zweiten Vorspannelemente mit dem ersten bzw. zweiten Untermesser verbunden sind.
10. Rasierapparat nach Anspruch 8 oder 9, wobei wenigstens eines der ersten und zweiten Vorspannelemente über Distanzstücke vorgespannt ist, die zwischen dem betreffenden Vorspannelement und dem Träger angeordnet sind.
11. Rasierapparat nach einem der Ansprüche 1 bis 10, wobei das zweite Untermesser im Innern des ersten Untermessers sitzt und ein Außenumfang der Untermesser-Baugruppe durch Umfangsränder der ineinander eingreifenden ersten und zweiten Messerblätter gebildet ist.
12. Rasierapparat nach einem der Ansprüche 1 bis 11, wobei das zweite Untermesser aus einem Kunststoff besteht.
13. Rasierapparat nach einem der Ansprüche 1 bis 12, der weiterhin einen Magneten zur Vorspannung der Messerblätter des zweiten Untermessers in Anlage an die Messerblätter des ersten Untermessers in wenigstens einer Richtung der Hin- und Herbewegung aufweist.
14. Rasierapparat nach Anspruch 13, wobei das zweite Untermesser wenigstens einen Pol einer ersten Polarität aufweist und das erste Untermesser dem wenigstens einen Pol des zweiten Untermessers benachbart wenigstens einen Pol einer zweiten Polarität aufweist, die der ersten Polarität entgegengesetzt ist.
15. Rasierapparat nach einem der Ansprüche 1 bis 14, wobei das zweite Untermesser in seiner Hin- und
- Herbewegung der des ersten Untermessers nach-eilt.
16. Rasierapparat nach einem der Ansprüche 1 bis 15, wobei das zweite Untermesser und das erste Untermesser so zusammenwirken, dass die ineinander eingreifenden Messerblätter sich aufeinander zu bewegen.
17. Rasierapparat nach Anspruch 16, wobei die ineinander eingreifenden Messerblätter sich so aufeinander zu bewegen, dass sie dazwischen erfasste Haare festklemmen.
18. Rasierapparat nach Anspruch 17, wobei die zusammenwirkenden zweiten und ersten Untermesser an den erfassten Haare ziehen, bevor sie abgeschnitten werden.
19. Untermesser-Baugruppe für einen Trockenrasierapparat mit einem Obermesser und einem Motorantrieb, wobei die Untermesser-Baugruppe umfasst:
- ein erstes Untermesser, das von dem Antrieb in eine Hin- und Herbewegung versetzbar ist und erste Messerblätter aufweist;
- gekennzeichnet durch** ein zweites Untermesser, das im Innern des ersten Untermessers verschiebbar gegenüber dem ersten Untermesser angeordnet ist und zweite Messerblätter aufweist, die mit den ersten Messerblättern in gegenseitigem Eingriff sind.
20. Untermesser-Baugruppe nach Anspruch 19, wobei das zweite Untermesser an dem ersten Untermesser gelagert ist.
21. Untermesser-Baugruppe nach Anspruch 19, wobei das zweite Untermesser unabhängig von dem ersten Untermesser gelagert ist.
22. Untermesser-Baugruppe nach einem der Ansprüche 19 bis 21, wobei das erste Vorspannelement so ausgelegt ist, dass es das erste Untermesser gegen das Obermesser vorspannt, und das zweite Vorspannelement so ausgelegt ist, dass es das zweite Untermesser gegen das Obermesser vorspannt.
23. Untermesser-Baugruppe nach Anspruch 22, wobei das zweite Vorspannelement zwei Schraubenfedern aufweist.
24. Untermesser-Baugruppe nach Anspruch 22 oder 23, wobei ein erstes Ende des zweiten Vorspannelements mit dem ersten Untermesser verbunden

- ist und ein zweites Ende des zweiten Vorspannelements mit dem zweiten Untermesser verbunden ist.
25. Untermesser-Baugruppe nach Anspruch 22 oder 23, die weiterhin einen Träger aufweist und wobei jeweilige erste Enden der ersten und zweiten Vorspannelemente mit dem Träger verbunden sind und jeweilige zweite Enden der ersten und zweiten Vorspannelemente mit dem ersten bzw. zweiten Untermesser verbunden sind. 5 10
26. Untermesser-Baugruppe nach einem der Ansprüche 19 bis 25, wobei das zweite Untermesser im Innern des ersten Untermessers sitzt und ein Außenumfang der Untermesserbaugruppe durch Umfangsränder der ineinander eingreifenden ersten und zweiten Messerblätter gebildet ist. 15
27. Untermesser-Baugruppe nach einem der Ansprüche 19 bis 26, wobei das zweite Untermesser aus einem Kunststoff besteht. 20
28. Untermesser-Baugruppe nach Anspruch 27, wobei die Messerblätter des zweiten Untermessers aus einem Kunststoff mit verstärkten Reibeigenschaften bestehen. 25
29. Rasierverfahren zur Anwendung in Rasierapparaten mit einer ein erstes Untermesser und ein zweites Untermesser aufweisenden Untermesser-Baugruppe, wobei die ersten und zweiten Untermesser ineinander eingreifende Messerblätter aufweisen, wobei das Verfahren folgende Schritte umfasst: 30
- Hin- und Herbewegen der Untermesser-Baugruppe in Scherbeziehung zu einem Obermesser; 35
- Bewegen des ersten Untermessers gegenüber dem zweiten Untermesser;
- Erfassen von zu schneidenden Haaren zwischen ineinander eingreifenden Messerblättern der ersten und zweiten Untermesser; 40
- Ziehen der erfassten Haare durch fortgesetzte Bewegung der Untermesser-Baugruppe in die jeweilige Richtung der Hin- und Herbewegung; 45
- und
- Abschneiden der Haare zwischen dem Obermesser und der Untermesser-Baugruppe.
30. Rasierverfahren zur Anwendung in Rasierapparaten mit einer ein erstes Untermesser und ein zweites Untermesser aufweisenden Untermesser-Baugruppe, wobei die ersten und zweiten Untermesser ineinander eingreifende Messerblätter aufweisen, wobei das Verfahren folgende Schritte umfasst: 50 55
- Hin- und Herbewegen der Untermesser-Baugruppe in Scherbeziehung zu einem Obermesser;
- Bewegen des ersten Untermessers gegenüber dem zweiten Untermesser in eine erste Richtung der Hin- und Herbewegung; wobei das zweite Untermesser von der Bewegung des ersten Untermessers mitgenommen wird und die Weiterbewegung des ersten Untermessers das zweite Untermesser zwingt, sich mit dem ersten Untermesser in die erste Richtung der Hin- und Herbewegung zu bewegen, Umkehren der Bewegungsrichtung des ersten Untermessers, wobei das zweite Untermesser von der Weiterbewegung des ersten Untermessers zur Richtungsumkehr veranlasst wird, und Abschneiden der Haare zwischen dem Obermesser und der Untermesser-Baugruppe.
31. Verfahren nach Anspruch 29 oder 30, wobei die zweiten Messerblätter gegenüber den ersten Messerblättern in Richtung der Hin- und Herbewegung mit einer relativen Verzögerung bewegt werden, wodurch benachbarte Messerblätter zum Erfassen von Haaren miteinander in Anlage gelangen.
32. Verfahren nach Anspruch 31, wobei die Messerblätter des zweiten Untermessers gegenüber den Messerblättern des ersten Untermessers in Abhängigkeit von der Trägheit des zweiten Untermessers nacheilen.
33. Verfahren nach einem der Ansprüche 29 bis 32, wobei weiterhin die ersten Messerblätter von einem ersten Vorspannelement gegen das Obermesser vorgespannt werden; und die zweiten Messerblätter von einem zweiten Vorspannelement gegen das Obermesser vorgespannt werden.
34. Verfahren nach Anspruch 33, wobei weiterhin das zweite Vorspannelement zwischen dem zweiten Untermesser und dem ersten Untermesser positioniert wird.
35. Verfahren nach Anspruch 33, zur Verwendung mit Rasierapparaten mit einem außerhalb des ersten Untermessers angeordneten Träger, wobei das Verfahren weiterhin folgende Schritte umfasst:
- Vorspannen des ersten Untermessers auf den Träger durch das erste Vorspannelement; und Vorspannen des zweiten Untermessers auf den Träger durch das zweite Vorspannelement.

#### Revendications

1. Appareil de rasage, comprenant :

un couteau extérieur présentant une pluralité d'ouvertures ;  
 un ensemble formant couteaux inférieurs adjacents audit couteau extérieur ; et  
 un moteur destiné à déplacer ledit ensemble formant couteaux inférieurs dans un sens de va-et-vient ;  
 ledit ensemble formant couteaux inférieurs comprenant un couteau inférieur primaire et un couteau inférieur secondaire qui sont agencés de telle sorte que les éléments de couteau des couteaux inférieurs primaires et secondaires sont mutuellement imbriqués ;

**caractérisé en ce que** le couteau inférieur primaire est accouplé audit moteur en vue d'entraîner celui-ci dans un sens de va-et-vient et dans lequel le couteau inférieur secondaire est monté en vue d'un mouvement par rapport au couteau inférieur primaire dans un sens de va-et-vient, de telle sorte que, en réaction au va-et-vient du couteau inférieur primaire, le couteau inférieur secondaire est animé d'un mouvement de va-et-vient par rapport au couteau inférieur primaire.

2. Appareil de rasage selon la revendication 1, dans lequel ledit couteau inférieur secondaire est monté sur le couteau inférieur primaire.
3. Appareil de rasage selon la revendication 1, dans lequel le couteau inférieur secondaire est monté indépendamment du couteau inférieur primaire.
4. Appareil de rasage selon l'une quelconque des revendications 1 à 3, dans lequel les couteaux inférieurs primaires et secondaires sont supportés sur un bloc de soutien qui peut être déplacé dans un sens de va-et-vient.
5. Appareil de rasage selon l'une quelconque des revendications 1 à 4, dans lequel le couteau inférieur primaire est sollicité en direction du couteau extérieur par un élément de sollicitation primaire et dans lequel le couteau inférieur secondaire est sollicité vers le couteau extérieur par un élément de sollicitation secondaire.
6. Appareil de rasage selon la revendication 5, dans lequel une première extrémité du second élément de sollicitation est reliée au couteau inférieur primaire et une seconde extrémité de l'élément de sollicitation secondaire est reliée au couteau inférieur secondaire.
7. Appareil de rasage selon la revendication 6, dans lequel l'élément de sollicitation secondaire comprend une paire de ressorts hélicoïdaux.
8. Appareil de rasage selon la revendication 6, dans lequel les éléments de sollicitation primaires et secondaires sont agencés sur au moins un support.
9. Appareil de rasage selon la revendication 5, dans lequel les premières extrémités respectives des éléments de sollicitation primaires et secondaires sont reliées à un support et les secondes extrémités respectives des éléments de sollicitation secondaires sont reliées aux couteaux inférieurs primaires et secondaires respectifs.
10. Appareil de rasage selon la revendication 8 ou 9, dans lequel au moins un des éléments de sollicitation primaire et l'élément de sollicitation secondaire est préalablement sollicité par des entretoises qui sont disposées entre l'élément de sollicitation respectif et le support.
11. Appareil de rasage selon l'une quelconque des revendications 1 à 10, dans lequel ledit couteau inférieur secondaire est emboîté dans ledit couteau inférieur primaire et une circonférence extérieure de l'ensemble formant couteau est formée par les bords périphériques des éléments de lame primaires et secondaires imbriqués.
12. Appareil de rasage selon l'une quelconque des revendications 1 à 12, dans lequel le couteau inférieur secondaire comprend une matière plastique.
13. Appareil de rasage selon l'une quelconque des revendications 1 à 12, comprenant en outre un aimant destiné à solliciter les éléments de lame du couteau inférieur secondaire pour les faire entrer en contact avec les éléments de lame du couteau inférieur primaire dans au moins un sens de va-et-vient.
14. Appareil de rasage selon la revendication 13, dans lequel le couteau inférieur secondaire supporte au moins un pôle d'une première polarité et le couteau inférieur primaire présente, adjacent à lui, au moins un pôle du couteau inférieur secondaire, au moins un pôle d'une seconde polarité opposée à ladite première polarité.
15. Appareil de rasage selon l'une quelconque des revendications 1 à 14, dans lequel le couteau inférieur secondaire est animé d'un mouvement de va-et-vient dans une relation de retard vis-à-vis du couteau inférieur primaire.
16. Appareil de rasage selon l'une quelconque des revendications 1 à 15, dans lequel le couteau inférieur secondaire et le couteau inférieur primaire coopèrent, de telle sorte que les éléments de lame imbriqués se déplacent en direction les uns des autres.

17. Appareil de rasage selon la revendication 16, dans lequel les lames imbriquées se déplacent en direction les uns des autres dans une relation de serrage avec les cheveux qui y sont coincés.
18. Appareil de rasage selon la revendication 17, dans lequel le couteau inférieur secondaire qui coopère et le couteau inférieur primaire tirent ledit cheveu coincé avant de couper ledit cheveu.
19. Ensemble formant couteaux inférieurs destiné à un rasoir du type sec présentant un couteau extérieur et un mécanisme d'entraînement du moteur, ledit ensemble formant couteaux inférieurs comprenant :
- un couteau inférieur primaire adapté pour être animé d'un mouvement de va-et-vient par le mécanisme d'entraînement et présentant des éléments de lame primaires ; **caractérisé par :**
- un couteau inférieur secondaire disposé dans ledit couteau inférieur primaire en vue d'un déplacement par rapport audit couteau inférieur primaire et présentant des éléments de couteau secondaires imbriqués avec lesdits éléments de lame primaires.
20. Ensemble formant couteaux inférieurs selon la revendication 19, dans lequel ledit couteau inférieur secondaire est monté sur le couteau inférieur primaire.
21. Ensemble formant couteaux inférieurs selon la revendication 19, dans lequel ledit couteau inférieur secondaire est monté indépendant du couteau inférieur primaire.
22. Ensemble formant couteaux inférieurs selon l'une quelconque des revendications 19 à 21, dans lequel
- l'élément de sollicitation primaire est adapté pour solliciter le couteau inférieur primaire vers le couteau extérieur et
- l'élément de sollicitation secondaire est adapté pour solliciter le couteau inférieur secondaire vers le couteau extérieur.
23. Ensemble formant couteaux inférieurs selon la revendication 22, dans lequel l'élément de sollicitation secondaire comprend une paire de ressorts hélicoïdaux.
24. Ensemble formant couteaux inférieurs selon la revendication 22 ou 23, dans lequel une première extrémité de l'élément de sollicitation secondaire est reliée au couteau inférieur primaire et une seconde extrémité d'élément de sollicitation secondaire est reliée au couteau inférieur secondaire.
25. Ensemble formant couteaux inférieurs selon la revendication 22 ou 23, comprenant, en outre, un support et dans lequel les premières extrémités respectives des éléments de sollicitation primaires et secondaires sont reliées au support et les secondes extrémités respectives des éléments de sollicitation primaires et secondaires sont reliées aux couteaux inférieurs primaires et secondaires respectifs.
26. Ensemble formant couteaux inférieurs selon l'une quelconque des revendications 19 à 25, dans lequel ledit couteau inférieur secondaire est emboîté dans ledit couteau inférieur primaire et une circonférence extérieure de l'ensemble formant couteaux inférieurs est formée par les bords périphériques des éléments de lame primaires et secondaires imbriqués.
27. Ensemble formant couteaux inférieurs selon l'une quelconque des revendications 19 à 26, dans lequel le couteau inférieur secondaire comprend une matière plastique.
28. Ensemble formant couteaux inférieurs selon la revendication 27, dans lequel les éléments de lame du couteau inférieur secondaire comprennent une matière plastique présentant des caractéristiques de friction accrues.
29. Procédé de rasage destiné à être utilisé avec un appareil de rasage présentant un ensemble formant couteaux inférieurs présentant un couteau inférieur primaire et un couteau inférieur secondaire, lesdits couteaux inférieurs primaires et secondaires présentant des éléments de lame imbriqués ; le procédé comprenant les étapes consistant à :
- déplacer l'ensemble formant couteaux inférieurs dans un mouvement alternatif dans une relation de rasage avec un couteau extérieur ;
- déplacer le couteau inférieur primaire par rapport au couteau inférieur secondaire ;
- retenir les cheveux qui doivent être coupés entre les éléments de lame imbriqués des couteaux inférieurs primaires et secondaires ;
- tirer lesdits cheveux retenus par un mouvement continu de l'ensemble formant couteaux inférieurs dans un sens de va-et-vient respectif ; et
- couper lesdits cheveux entre le couteau extérieur et l'ensemble formant couteaux inférieurs.
30. Procédé de rasage destiné à être utilisé avec un appareil de rasage présentant un ensemble formant couteaux inférieurs présentant un couteau inférieur primaire et un couteau inférieur secondaire,

lesdits couteaux inférieurs primaires et secondaires présentant des éléments de lame imbriqués ; le procédé comprenant les étapes consistant à :

déplacer dans un mouvement alternatif l'ensemble formant couteaux inférieurs dans la relation de rasage des cheveux avec un couteau extérieur ; 5  
 déplacer le couteau inférieur primaire par rapport au couteau inférieur secondaire dans un premier sens de va-et-vient ; 10  
 moyennant quoi, ledit couteau inférieur primaire de déplacement entraîne le couteau inférieur secondaire et le mouvement continu du couteau inférieur secondaire contraint le couteau inférieur secondaire à se déplacer avec le couteau inférieur primaire dans le premier sens de va-et-vient, 15  
 inverser le sens de déplacement du couteau inférieur, 20  
 moyennant quoi, le mouvement continu du couteau inférieur primaire amène le couteau inférieur secondaire à inverser de sens, et  
 couper les cheveux entre le couteau extérieur et l'ensemble formant couteaux inférieurs. 25

31. Procédé selon la revendication 29 ou 30, comprenant l'étape consistant à amener les éléments de lame secondaires à se déplacer par rapport aux éléments de lame primaires dans un sens de va-et-vient dans une relation de retard par rapport à ceux-ci, par lesquels fournir un contact entre les éléments de lame adjacents pour retenir lesdits cheveux. 30

32. Procédé selon la revendication 31, dans lequel les lames du couteau inférieur secondaire sont en retard sur les lames du couteau inférieur primaire en réaction à l'inertie du couteau inférieur secondaire. 35

33. Procédé selon l'une quelconque des revendications 29 à 32, comprenant, en outre, les étapes consistant à : 40

solliciter les éléments de lame primaires en direction du couteau extérieur par un élément de sollicitation primaire ; et 45  
 solliciter les éléments de lame secondaires en direction du couteau extérieur par un élément de sollicitation secondaire. 50

34. Procédé selon la revendication 33, comprenant, en outre, l'étape consistant à positionner l'élément de sollicitation secondaire entre le couteau inférieur secondaire et le couteau inférieur primaire. 55

35. Procédé selon la revendication 33, destiné à être utilisé avec un appareil de rasage comprenant, en outre, un support externe du couteau inférieur pri-

maire, et le procédé comprenant, en outre, les étapes consistant à :

solliciter le couteau inférieur primaire vers le support à travers l'élément de sollicitation primaire ; et  
 solliciter le couteau inférieur secondaire vers le support à travers l'élément de sollicitation secondaire.

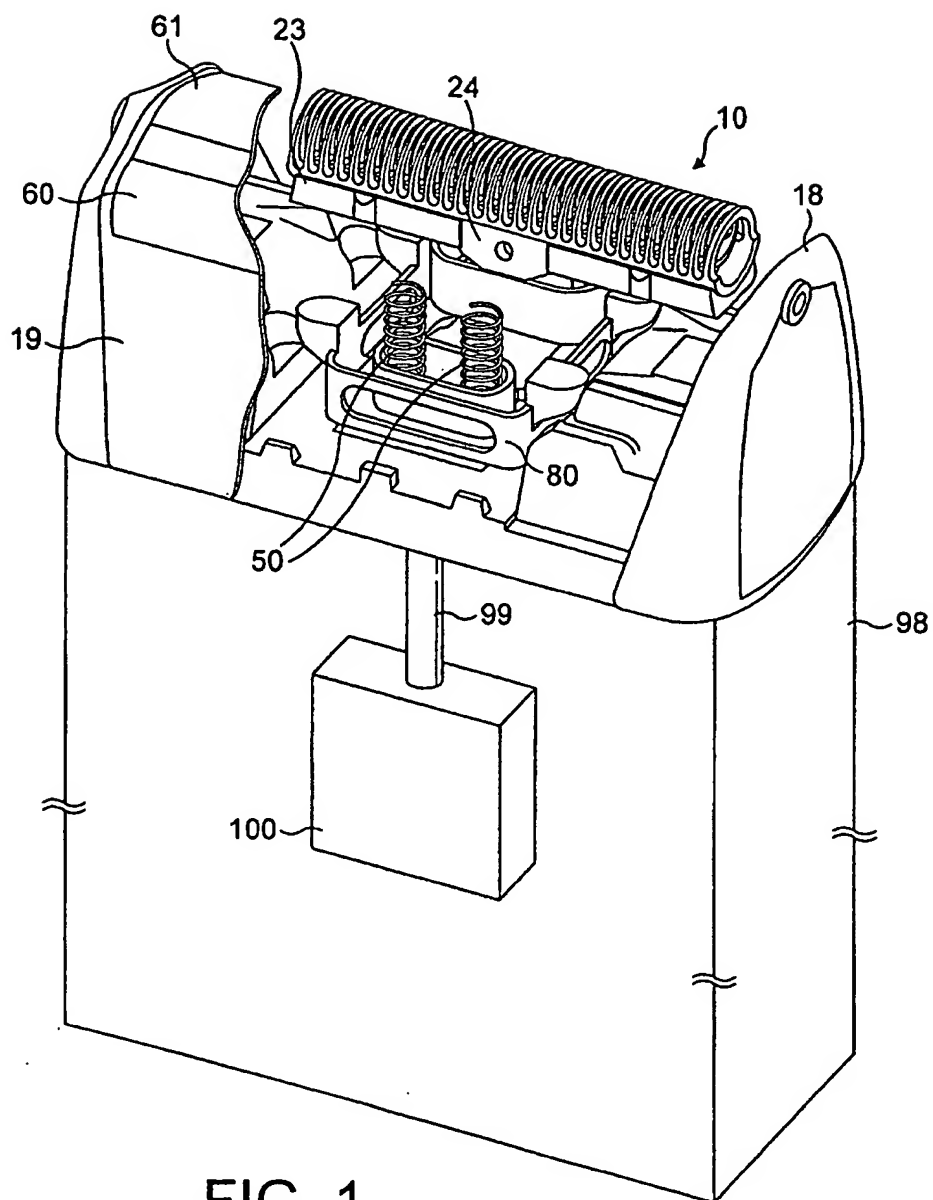


FIG. 1



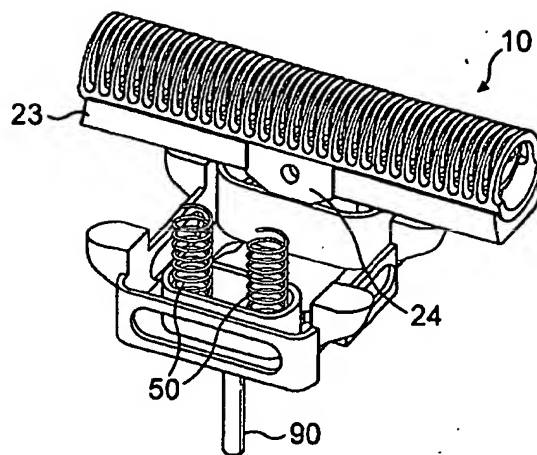


FIG. 1A

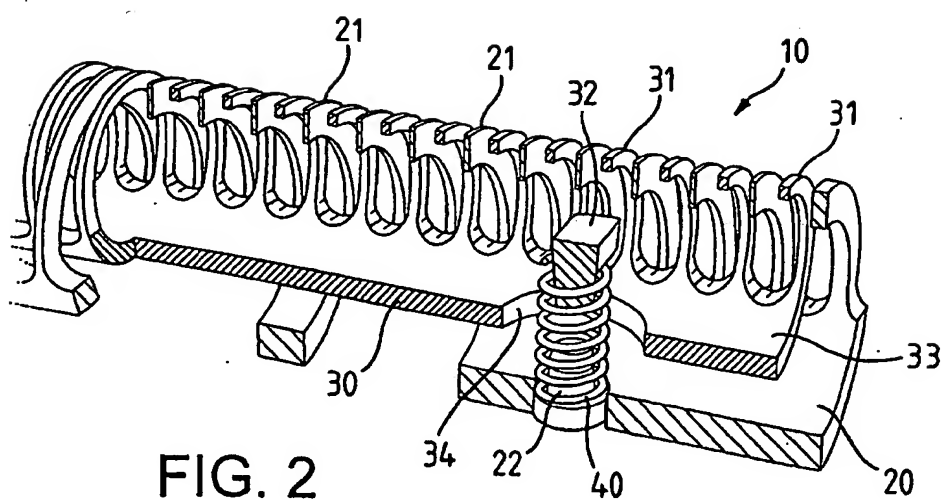
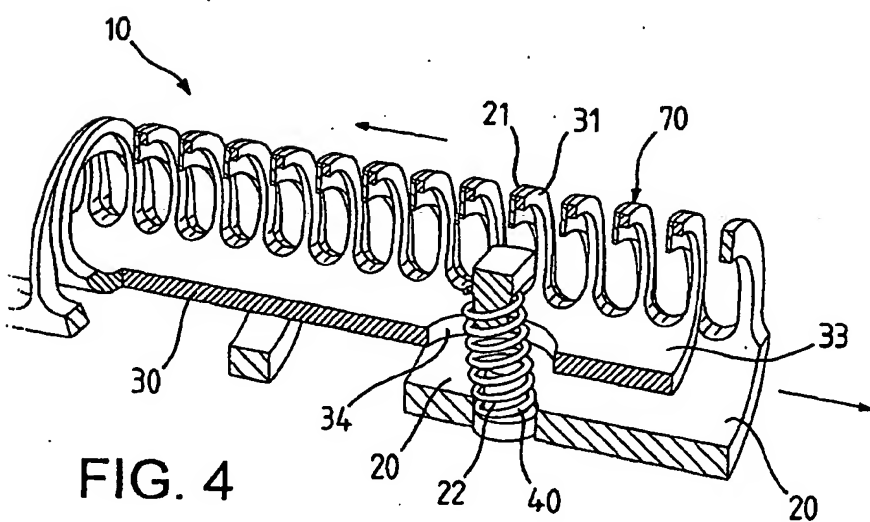
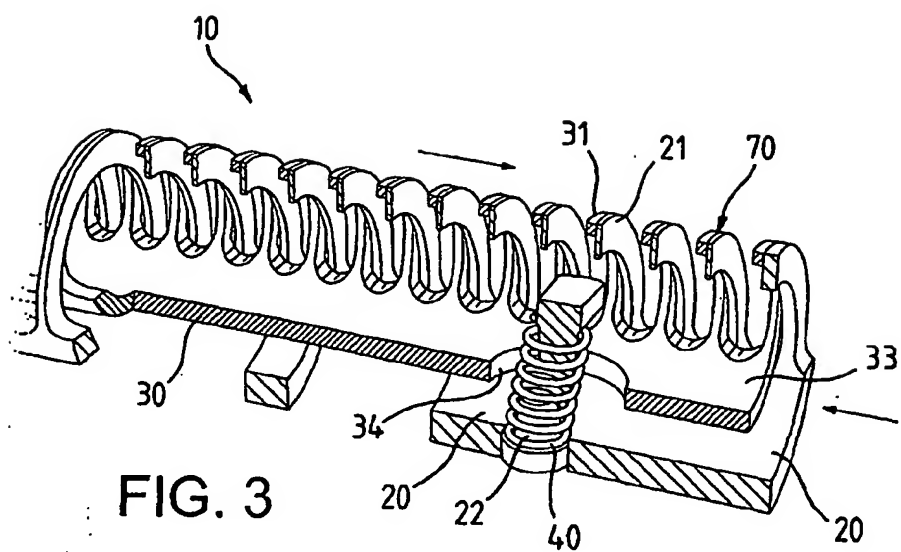


FIG. 2



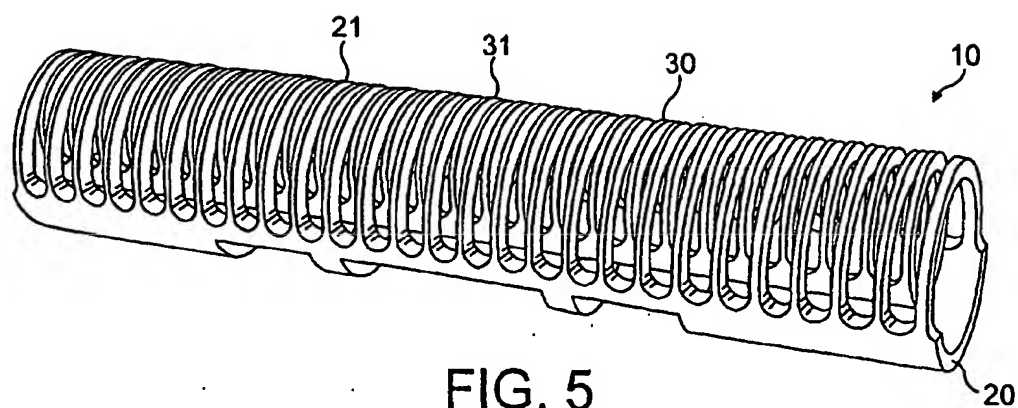


FIG. 5

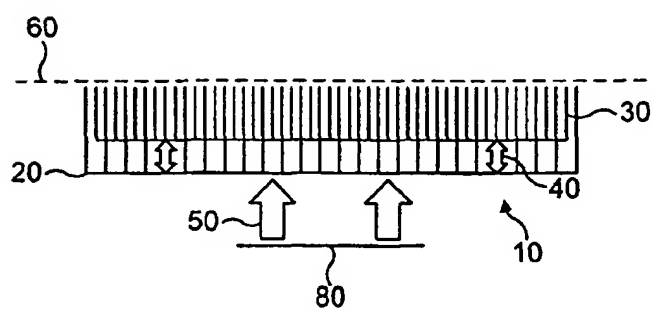


FIG. 6

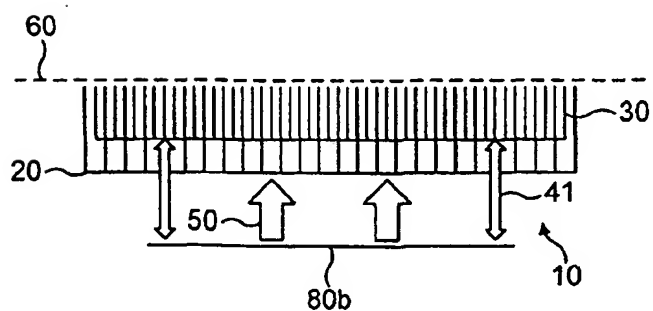
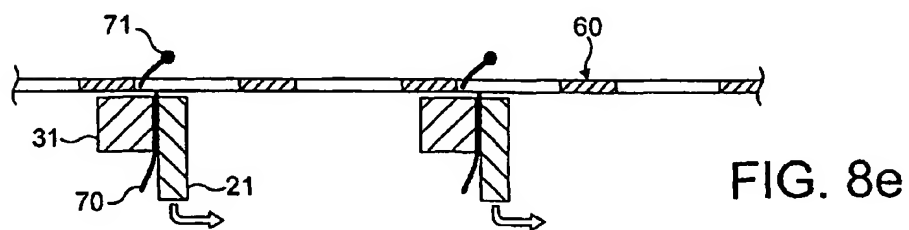
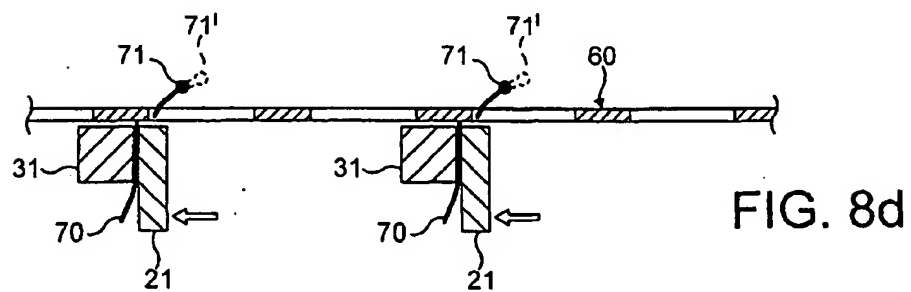
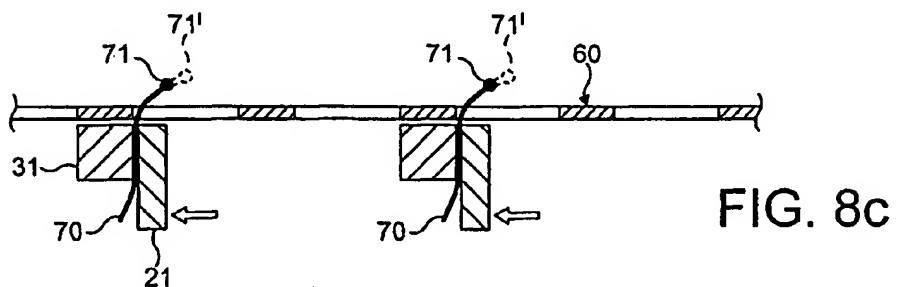
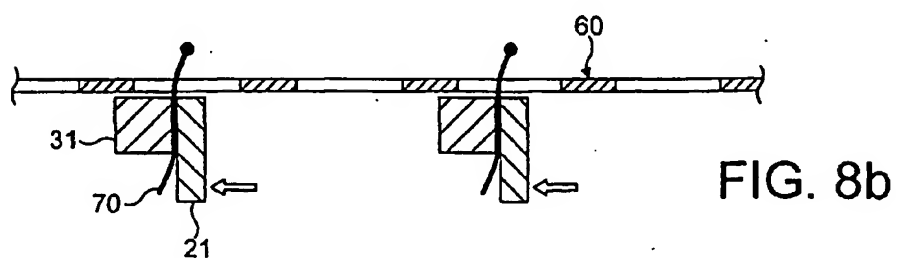
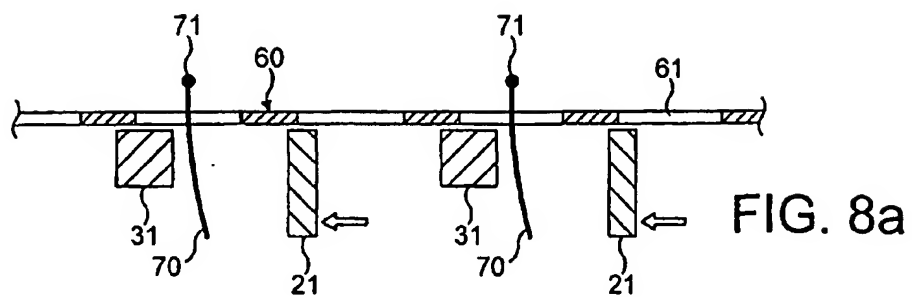
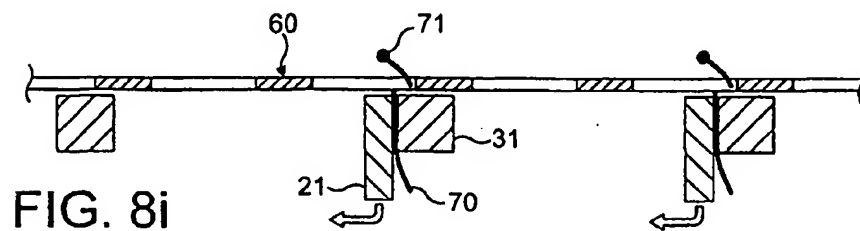
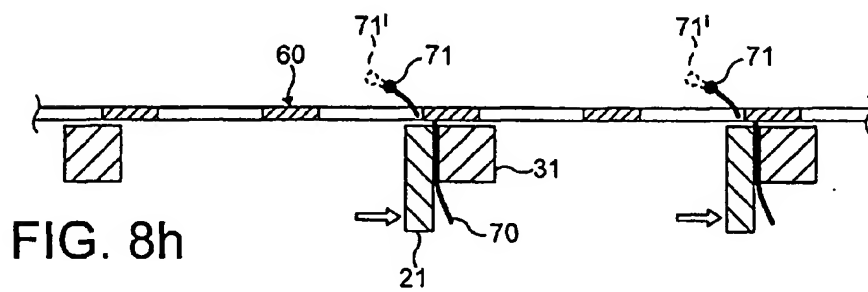
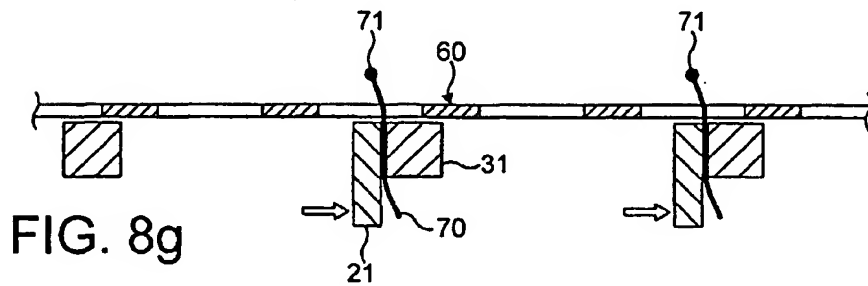
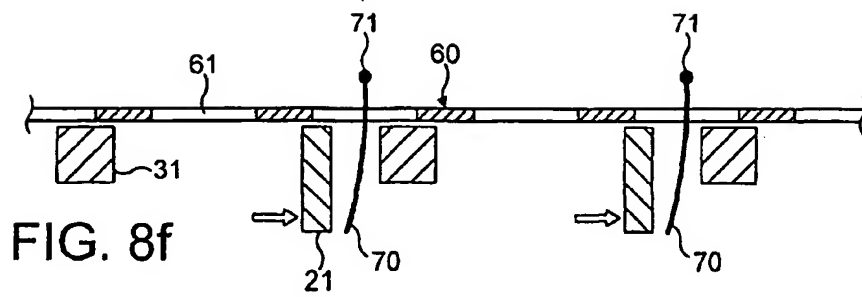


FIG. 7





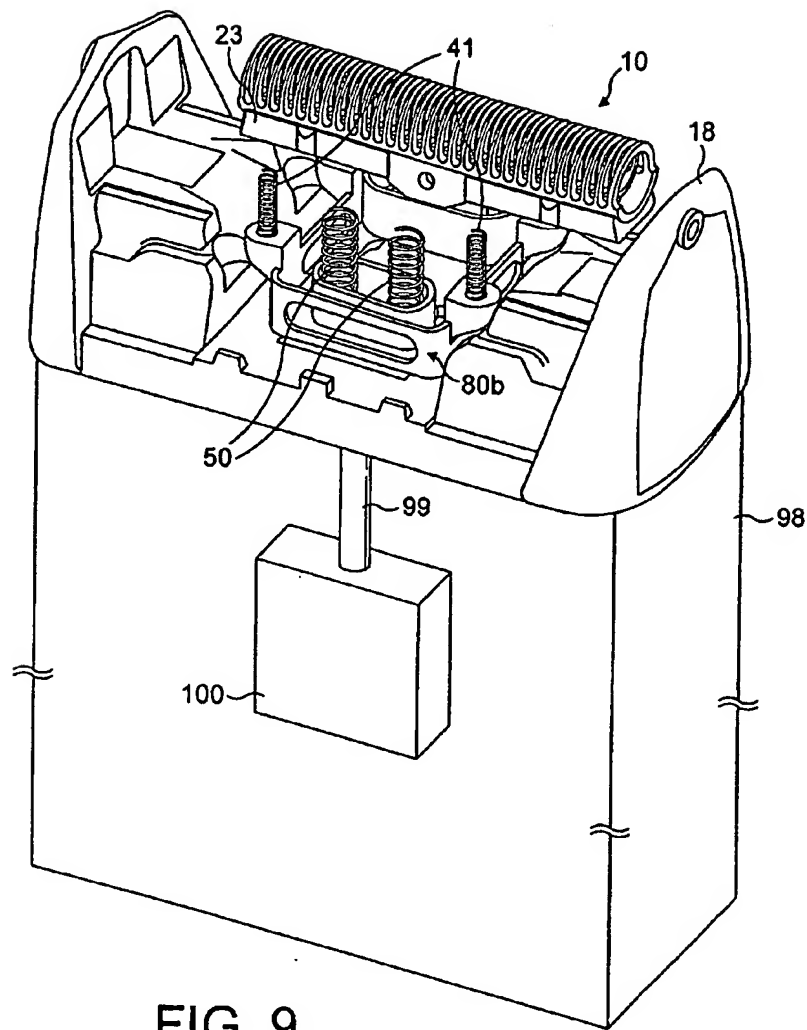


FIG. 9

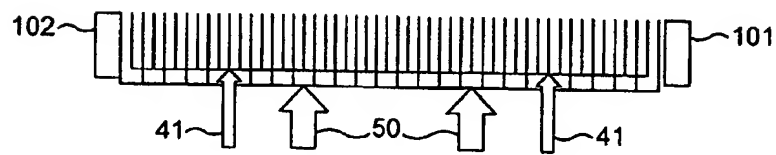


FIG. 10